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## An Analytic Study of Faunal Changes in Indiana.

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It is a matter of common knowledge that the fauna and flora of the Central States have changed greatly during the last century. The changes in Indiana have been referred to incidentally or discussed at some length in various places.\* An extensive analysis of them has not been published heretofore.

The greatest obstacle to such an analysis is the lack of positive information as to the former abundance of most species. From local histories, tales of exploration, reminiscences of "oldest inhabitants," and the like we can obtain a fairly accurate picture of the larger species, the game birds and animals and even the larger fishes. But our knowledge of the former abundance of the native mice, the chipmunks, the less conspicuous birds, the smaller fishes, and more particularly of the mollusks, crustaceans, insects and other small creatures, is necessarily very limited. In some instances, deductions can be drawn from the position the species occupies in the general scheme of nature.

It is the purpose of this article to collate and discuss the data that are available on the subject. The facts to be considered may be grouped under the following heads:

1. The extermination of the bison at about the time white settlers became numerous.

2. The extermination of the beaver, cougar and wapiti not long after the disappearance of the bison.

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\* Butler, Bulletin Brookville Soc. Natural History, No. 1, 1885, pp. 5-13. Proc. Ind. Academy of Science, 1895, pp. 31-42. Culbertson, Proc. Ind. Academy Science, 1908, pp. 27-37. Hahn, 33rd Ann. Rep't. Dep't. Geology and Nat. Resources of Indiana, pp. 418-663.

† February 15, 1910.—Pages 145 to 164.

3. The final extermination of the deer long after its relative, the wapiti, had become extinct.

4. The extermination, partial or complete, of nearly all of the Carnivora.

5. The ability of the red fox and coyote to maintain their existence where other species, related to them, and with similar habits, have been extirpated.

6. The differential reduction in number of the larger rodents, the porcupine being extinct, and the gray squirrel having suffered more from advancing civilization than the fox squirrel.

7. The probable increase of many small rodents.

8. The practical or complete extermination of the pileated and ivory-billed woodpeckers, paroquet, passenger pigeon, prairie chicken, wild turkey and ruffed grouse.

9. The marked decrease in number of waterfowl.

10. The notable increase in number and extension of the range of many passerine birds.

11. A marked decrease in number of many fishes, mollusks and other aquatic animals.

12. An increase in number of certain insects, accompanied by an extension of their range.

13. A decrease in number of a few species of insects.

We will now consider, with as much detail as space allows, the factors that render some species more fit than others in the struggle for existence under the conditions that have existed in this State during approximately a century and a quarter — namely the manrelation.

## MAMMALS.

### THE BISON.

The facts concerning the extermination of the bison are too well known to require a lengthy discussion. Hornaday\* ('89) recognized two periods of extermination, that of desultory destruction, from 1730 to 1830, and the period of systematic destruction, from 1830 to 1888. The first period embraces the disappearance of the species from all of the territory east of the Mississippi. According to Hornaday, during the first period it was killed by the settlers principally for food; during the second it was wantonly butchered for hides and tongues.

However, it is the purpose of the present paper to ask

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\* The Extermination of the American Bison, W. T. Hornaday, Report of the U. S. National Museum for 1887, pp. 369-548. See also 33rd Ann. Report Indiana Dep't. of Geology and Natural Resources, pp. 425 and 452.

the reason, from a biological standpoint, for the early disappearance of the race. The reasons are several in number and it is not possible to say that any one is of much greater importance than the others. To quote again from Hornaday, "His dullness of intellect was one of the most important factors in his extermination." This dullness of intellect manifested itself chiefly in a stupid disregard for danger: the animals instead of trying to escape often stood quietly watching the death struggles of their companions who fell before the rifle of the still hunter.

Such stupidity would not be possible in a wild species that was not very perfectly adapted to its surroundings by sufficient size and strength to render it immune to attacks by enemies. Large size, which was advantageous in enabling the animals to overcome their brute enemies, only served to make them more desirable game for man, without protecting them in the least. The habit of association in large herds, also protective under primeval conditions, served to hasten their extermination when man came upon the scene.

We must also take into account the fact that the high specialization of the bison had probably brought it to the zenith of its development as a species. The family *Bovidae*, to which it belongs, is apparently a decadent one, decadent primarily because it is not adapted to the manrelation. The various antelope of Africa, now so rapidly disappearing, are members of this family as are the decadent bison of Europe and the aurochs which was exterminated during mediaeval times. In historic times the American bison has been without near relatives on this continent, although fossil bisons are found in strata of comparatively recent geological periods. It is not possible to say whether these facts have any importance bearing upon the extermination of the species, but the rise and fall of species, genera and larger groups during past ages seems to have a biological as well as a geological significance.

#### THE BEAVER.

The beaver although much smaller in size, was exterminated shortly after the bison. The commercial value of its fur excited the greed of trappers and early settlers and led them to hunt it almost as vigorously as the bison. Like that animal, the beaver was very gregarious, and was therefore more easily trapped or shot. Had it been more prolific, like the muskrat, or more wary, like the mink, it would have escaped extermination much longer, but it also was highly specialized for a particular mode of life wherein it had been comparatively secure.

## WAPITI AND DEER.

Wapiti and deer belong to the same family but to different genera. The former species is much larger than the latter and was never as numerous. Both species thrive on the coarsest kinds of food, dead leaves, twigs, weeds, and other coarse plants being both nutritious and palatable for them. Therefore their extermination was not due to lack of food.

Wapiti, or elk as it is frequently, although incorrectly, called, had become scarce in this State previous to 1810 and became extinct about 1830. Deer were not uncommon in many localities in 1850 and did not become extinct till 1893.

What enabled deer to survive sixty years longer than wapiti with a rapid increase in population? In a general way their habits are similar, their food is not essentially different and they occupied the same territory.

According to Roosevelt ('02) "Wapiti are the most gregarious of the deer family." During the mating season, which is in September, they congregate in large herds. They are highly polygamous and the males fight violently for the females and become very noisy.

Deer sometimes band together but do not gather into large and compact herds under the leadership of a single old buck as do wapiti, nor do they become as noisy. In a region where they are much hunted, they hide away during the daytime in dense thickets or inaccessible swamps. They are more prolific than wapiti, beginning to breed at an earlier age and frequently producing two young at a time.

Deer are timid, fleet and wary. Wapiti are usually shy, but lose all their wariness at mating time; even at other times they may exhibit surprising stupidity and make no attempt to escape from danger.

In short, deer survived longer than wapiti because they are smaller, more timid, less gregarious and more prolific. The permanent survival of wapiti in the wild condition in such a region as this State affords was out of the question. If any remained at the present time, they would be an intolerable nuisance. Deer might have been preserved in rugged or marshy localities, as they are in many of the eastern states, had they been given adequate protection. Clearing away the forests, draining swamps and placing the land under cultivation left them without hiding places and they became easy prey for hunters.

quarter — namely the man-relation.

## THE LARGER CARNIVORA.

The first of the Carnivora to disappear was the cougar.

In contrast to the preceeding species, it furnished no products of much value to man. But it caused the early settlers to fear for their lives and it also destroyed their domestic animals. Consequently it was eagerly hunted. Like the bison, it had been immune from danger because of its size and strength, and therefore was not prolific. The encroachment of civilization increased the death rate by a large percentage and resulted in the rapid disappearance of the species.

Bears became rare about 1840 but not extinct before 1878. They are to be classed as game animals, for not only was their flesh highly prized, but the killing of a bear was always considered quite a feat of sportsmanship. They were thought to be dangerous to human life, although there are few instances on record of an unprovoked attack upon a human being. They did some damage, however, by carrying off pigs and occasionally other domestic animals. For these reasons a bear hunt always followed the appearance of one of the animals in any community, and they owed their long survival to the fact that after the country became thickly settled, they retreated to the swamps where they remained in hiding most of the time.

The Canada lynx and the smaller bay lynx are so hopelessly confused in the zoological literature of the State that it is not possible to distinguish their records. Both were commonly called "catamount" or "wild cat." The first of these species has undoubtedly been extinct for a number of years. The second has not been common for half a century but was killed within the State as recently as 1906 (Hahn '09a), and may yet exist in the less accessible swamps. The cause of their extermination, like that of the other Carnivora, was chiefly their depredations upon domestic animals and the fear in which they were generally held. The Canada lynx is a dweller of the great forest and those individuals that were not killed outright doubtless retired voluntarily before oncoming civilization. The bay lynx has been able to survive because it has, to a large extent, abandoned its predatory habits and retreated to the swamps where it remains in hiding most of the time, subsisting on the wild life about it.

The gray or timber wolf was very abundant when the State was first settled but has been comparatively rare for five or six decades although it has been killed in Knox County as recently as 1908 (Hahn '09a). The early reduction of the species was due to its destructive habits, and the survival of a few representatives to the fact that they learned to "lay low."

The coyote was also numerous at one time, then became very rare, and during the last ten or twelve years has again increased to such an extent that it bids fair to overrun the

entire State and become a serious pest. It has been able to learn by experience to such a degree as to become adapted to the man relation. In so far as we are able to judge, this adaption has been almost wholly of a mental character. The coyote is intelligent and teachable and has solved for itself the problems that it had to face. In this it is like its relative, the red fox. Just what change has taken place in the coyote's habits, I am unable to say. The animals still hunt in packs and they still molest poultry and other small domestic animals. But they seem to have learned to avoid traps and poison and to spend most of their time at a distance from human habitations.

The red fox was referred to above as an example of a species that has become adapted to the manrelation, but the gray fox differing very little from the red in size and habits, has been gradually decreasing in all parts of the State. The two species are not very closely related in spite of their external resemblance. The gray species is unquestionably a native of the region, while the red is not, and may even be an importation from Europe. If the latter supposition is the true one, the species has been gradually acquiring the ability to live in close proximity to man during his progress from savagery to civilization, instead of having to acquire it in a few generations after man had already learned the use of guns and traps.

#### THE SMALLER CARNIVORA.

Under this head we may include the raccoon and all of the members of the family *Mustellidae*, although some of the latter are nearly equal in size to the foxes.

The raccoon is not of very great economic importance although it commits some depredations on poultry and its skin has some commercial value. It is a forest dweller and its natural habitat has been largely destroyed, but it is adaptable and in some places has taken up its residence in drains and ditches. Nevertheless it has been decimated during the past century. This is due, in part, to the curiosity of the animal which leads it to explore every fallen log and investigate every unusual object and thereby makes it easily trapped. The clumsiness of the raccoon makes it unable to escape pursuit in any way except by climbing, and made it easier to capture and kill, and thereby making 'coon hunting a popular sport.

Otters are semi-aquatic animals possessing a furry coat of much value. These two facts account for the almost complete extermination of otters in our State. They frequent water courses, and have regular pathways along the banks,

and slides going down to the water and consequently are easy to trap.

The mink is a relative of the otter but is less aquatic and its hide has less value. On the other hand, it often raids poultry yards and so incurs greater danger. It is swift of foot, cunning and resourceful, although not especially shrewd in avoiding traps. Its cunning and its ability to hide enable it to still exist, though in greatly diminished numbers. The weasels are but smaller editions of the mink and are able to hold their own better because of the lesser value of their fur and their inconspicuous size.

#### THE RODENTS.

Aside from the beaver, the most interesting of these is the porcupine. It is almost unique in having no economic importance whatever, being in no wise destructive and having practically no use. Destruction of the forests which it inhabited may account, in part, for its disappearance. But its extermination was due principally to the spiny armor that it wore. This coat had rendered it practically immune from danger from other animals and its birth rate was consequently low. In addition to this, it was sluggish in disposition and indifferent to danger. But one of the most important factors in its extermination was probably the extraordinary appearance which the long spines gave to the animal. These made it conspicuous and led men to kill it merely from curiosity, as they kill any strange creature that attracts their attention.

Tree squirrels were comparatively safe from beasts of prey because of their arboreal habits. They were very abundant when the State was first settled and have since been more than decimated. The first considerable destruction was due to the efforts of the pioneers to protect their crops against the ravages of the innumerable hordes of squirrels. Later, deforestation aided in their reduction, and hunting for sport and food has continued the slaughter.

There is unquestionable evidence (Hahn '09a) that the gray squirrel was the more numerous species when the State was first settled. At the present time fox squirrels are fairly common in most of the groves of trees remaining about the farms. The gray squirrel, on the other hand, is rare outside of the most extensive of the remaining tracts of timber. I am unable to suggest any reason for the change in relative numbers of the two species. The fox squirrel seems to be better adapted to the manrelation, perhaps because of certain neutral qualities that enable it to escape danger more readily, perhaps because of greater hardiness or some other characteristics that have escaped our notice. It may be noted in passing



that the eastern fox squirrel, subspecifically different from ours, has been nearly exterminated where the gray squirrel still thrives.

Chipmunks and other ground-squirrels, woodchucks, rabbits, muskrats, moles and mice are all comparatively weak creatures and were successfully hunted by many enemies of the primeval forest and trackless prairie. Most of these beasts and birds of prey have been either exterminated or greatly decreased in number, and persecution of the weaker species from at least one source has been lessened. None of the latter endanger the life of man and although they destroy his grain, they do so, little by little, and therefore his desire to destroy them is usually at low ebb. They are too small to be of any value dead and too insignificant to be hunted for sport. Those species that live preferably in grassy places have as large a range now as formerly, for roadsides, pastures overgrown with bushes and similar situations take the place of the former extensive woodlands.

Therefore we may safely assume that this group of animals, on the whole, has increased although little mention is made of them in accounts of the early settlement of the State and we have no means of comparing past and present numbers.

One species included under this head should have especial mention. The muskrat is trapped and hunted for its fur just as the beaver, mink, otter and others have been. It has diminished in number as a result of this persecution, but not as much as the other species, the reason being that it has always had, and is adapted to a high death rate. Man has added to the slaughter inflicted upon the muskrat by wolves, foxes, otters, minks, weasels and other animals, but at the same time he has been the cause of a diminution of the slaughter from these sources.

## BIRDS.

Birds occupy a peculiar place in our regard, being universally beloved because of the beauty of plumage, grace of motion or melody of song. Added to these aesthetic qualities we have the usefulness of birds in destroying insects, although in this they are equalled by the despised frogs and other batrachians.

Birds have therefore been protected to an unusual degree in spite of the greed of plume and wing hunters. Yet several species have nearly or wholly disappeared and many others are decimated.

Probably the ivory-billed woodpecker was the first species

to disappear. Data concerning its occurrence in this State are very meager. Wied mentions all of the other woodpeckers of this region in his New Harmony list of 1832-33, but omits the ivory-billed. It was probably about extinct at that time. It was the largest of all our woodpeckers as well as the most handsome and was no doubt wantonly killed because it afforded a conspicuous target for the pioneer riflemen. Like the bison, it was doubtless without formidable enemies and highly specialized for a particular environment, hence when this environment, the vast uninhabited forest, began to disappear the species was unable to stand the stress of conditions. The pileated woodpecker nearly equalled the ivory-billed in size and, like it has almost disappeared.

These two woodpeckers were never very numerous, but the Carolina paroquet and the passenger pigeon were once extremely abundant. The last record of the paroquet in Indiana is in Knox County, in 1859 (Butler '97), although it became rare in most parts of the State twenty years earlier.

The extermination of these birds was due largely to their destructive habits. Both orchards and grain fields suffered from their depredations and they destroyed quantities of fruit and grain in addition to what they ate. They had the habit of gathering in large flocks and sweeping down upon an orchard or a field of ripening wheat and this not only incited the farmers to destroy them but also made destruction the easier.

The passenger pigeon was even more gregarious than the paroquet and also much more numerous. We are told of solid flocks of the flying birds five miles long by one mile wide. Near Petoskey, Michigan, they had a nesting site twenty-eight miles long and three or four miles wide where every tree of the forest contained from one to many nests (Butler '97). Other large flocks, roosts and nesting grounds were common. While the birds probably ate some grain, I know of no evidence that they were especially destructive. But they made good food and had a ready sale and consequently were much hunted. It is estimated that 3,000,000 birds went to market from the Petoskey nesting grounds in 1878, and twice that number perished as the result of wounds and the starvation of nestlings. It is easy to see why the extermination was so rapid under such a system as this, but from the standpoint of the species, the gregarious habit was the fatal adaptation.

The gallinaceous birds were formely represented in this State by four species, the wild turkey, bob-white, ruffed grouse and prairie hen. The first is the largest and is wholly or nearly extinct within our borders; the domestic turkey being descended from another race. The second is the smallest, and, being very prolific, is still found in all parts of the State, al-

though not nearly as abundant as formerly. The other two are intermediate in size and were therefore hunted in preference to the bob-white, and being less prolific, they have become almost extinct, but their shyness has prolonged their existence to the present time.

The ducks, geese, snipe, plover, rails, loons, cranes, herons, etc., constitute a great, heterogenous group of water birds. These were found in enormous numbers about the lakes, swamps and streams before the State was settled. The group as a whole, and probably every species in it, has diminished in numbers, partly because of hunting and partly because their nesting and feeding grounds have been destroyed by draining and clearing the land.

The hawks and owls and other raptorial birds constitute another group having a distinct ecological position. They are compelled to compete with the carnivorous mammals for food and as these have diminished they have gained an advantage. But some of them have preyed on poultry and thereby have aroused man's enmity. As a consequence he has made war upon all species without discriminating between the beneficial and the injurious. The larger species, as the eagles, have greatly diminished in numbers. Some of the prairie species have increased for a time perhaps, but there has been a general, though not uniform, reduction of the Raptores.

The Order Passeres includes all of our songsters, in fact, the vast majority of the smaller and more common birds of field and garden and almost the only species that regularly visit the cities. None are of very large size and none are truly rapacious. Most of them feed wholly on seeds or insects. Hence there is no shortage in food supply, while a decrease in the number of carnivorous mammals and raptorial birds has removed some of their most dangerous enemies.

The species of the group have diverse habits. The warblers, kinglets, vireos and flycatchers are principally woodland birds, but most of the species take kindly to the presence of man and may be seen about groves and orchards, and even in the shade trees that line city streets. Many of the warblers are known to us only as migrants and there is little evidence to show that their numbers have changed. The vireos and warblers that stay with us, nest in open groves and about habitations. Five or six of the flycatchers are shy woodland birds and may have diminished as the forests are cleared.

Crows and jays are reckoned as destructive birds but they are also cunning and well able to care for themselves under most circumstances. They are not especially fond of the forest and I suspect that they may have been on the increase

sixty or seventy years ago but are slowly diminishing at present.

The blackbirds are also destructive and the bronzed grackles have diminished to a marked degree because farmers have shot them to protect crops. The bobolink and red-winged blackbird frequent swamps and marshes and as these have been drained the birds have diminished. On the other hand, the meadow lark is seldom seen far from well drained grass lands. The southern part of the State has changed from heavy forest to pasture and meadow and with the loss of the forests has come an increase of these birds. The orioles love the open woods and orchards and they have probably increased rather than diminished.

The majority of the sparrow family are also grass lovers. The dickcissel first appeared in Franklin County between 1869 and 1879 (Butler '85), and there are records of its first appearance in many other places. The grasshopper sparrow, vesper sparrow, lark sparrow, field sparrow and others must certainly have had the same history, as their habits make it impossible to believe that they were inhabitants of the greater part of southern Indiana a century ago, although now abundant in that region. The most recent intrusion of the prairie avifauna is the Harris sparrow, a species abundant on the plains west of the Mississippi, but first taken in this State at Sheridan on May 4, 1907 (Butler, '08),

The grosbeaks, also members of the sparrow family, are frequenters of the wood rather than the meadow and are probably diminishing. At least that is the writer's personal observation with regard to the cardinal in southeastern Indiana. The same may be true of some other finches, as the fox sparrow and white-throated and white-crowned sparrows, but they are only migrants and the abundance would not be affected by changes of conditions in this State.

The grass-inhabiting sparrows have extended their range eastward, and in this State probably southward. The mocking bird has extended its range northward. The writer is uncertain whether this bird occurred about his former home in southern Indiana during the period ending with 1900, but he is under the impression that it was a rare summer resident. It certainly was not common. During the past six or eight years it has become very abundant. (Hahn, '09b.)

Mocking birds have also become more abundant at Bloomington and have been noted at many localities in the southern third of the State. The species has been an accidental visitor in all parts of the State and evidently is now occupying much of its former accidental range because conditions have changed in some way that has reduced the struggle for existence. The

destruction of forests and diminution of enemies are probably the principal elements in this change.

There is not space to discuss further changes in the bird fauna, even by families, but it may be pointed out that the house, Bewick's and Carolina wrens and bluebirds are other species that have increased in numbers with the settlement of the region. Their preference for the vicinity of man is doubtless a recent acquirement and the result of better protection.

To sum up the changes in the avifauna, the larger species, the more specialized species, the species that are real or supposed enemies of man's welfare, the species that are desirable game, the species that frequent marshes and the species that dwell in the deep woods have all suffered with the populating of the State. The species that frequent human habitations, those that are weak and not destructive in habit, and more especially those that are inhabitants of the drier meadows, pastures and orchards have increased in numbers and have extended their range and are still extending it.

I am of the opinion\* that there are as many species nesting and resident in the State now as when Audubon and Wilson visited the region nearly a century ago. I doubt that the individuals are less numerous. They are certainly smaller in size, on the average, and most of the more peculiar types have diminished or disappeared.

(To be continued.)

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\*This is contrary to views often expressed. For a confirmatory opinion relating to Chester County, Pennsylvania, see Sharples, Bird Lore, 1909, pp. 263-264.

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## The Plateau du Coteau du Missouri.

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J. LUNELL.

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When reading Doctor Greene's paper on North Dakota *Thalictra* I noted with satisfaction that introduction to the subject which took the form of an account of the particular topography of our region, and admired it all the more because I know that the writer had never visited this part of North Dakota, and did not doubt that he had gathered those important geographic data from maps chiefly; and I was gratified by this demonstration of the fact that four different floras meet here on neutral ground, intermingle and mutually impress one another. The present writer, having studied the botany of this territory for more than twenty years, can only confirm the correctness of Dr. Greene's theory.

The elevated barrier, whose real name is The Plateau du Coteau du Missouri, runs in a fairly straight direction from the northwestern corner of the state, where the elevation is about 2500 feet above the sea, to the southeastern end, and is the great divide between the Missouri basin on its western slope, and the basins of the Souris River and the Red River of the North on the east side of it. East of the Souris River the country rises about 500 feet above the prairie, or 2000 feet above the sea, and this elevation, called Turtle Mountains, is 40 miles long and 20 miles wide. No turtles are found there, but it had its name from the Indians on account of its fancied resemblance to that animal. It has quite many lakes, drained by rivulets which flow to the Souris. Where